Chapter 3
Thermal Spray Materials

3-1. Introduction

This chapter is intended to provide the engineer with an understanding of how thermal spray coatings are specified, procured, and tested prior to being applied. Thermal spray coating materials can be specified by describing the composition of the wire or powder, by product name and manufacturer, and by citing the material descriptions herein. Thermal spray wire and powder testing, including sampling procedures, material identification, and coating performance testing, is critical in establishing whether the supplied materials meet the composition requirements and whether they will provide the desired level of corrosion protection to the structure. This chapter will provide the engineer with an understanding of the various tests that can be performed and what the test data mean in terms of thermal spray coatings performance.

3-2. Specifications

Thermal spray coating materials can be specified by product name and manufacturer or by using a material description. Each method of specification will be discussed.

a. Specification by product name/manufacturer. The product name of a manufacturer is one way to specify a coating material. Private industry often specifies thermal spray materials by product name/manufacturer; however, the USACE does not purchase materials in this way. Specifying thermal spray materials by product name/ manufacturer can be beneficial when a specific thermal spray coating material has proven successful. Technical information and advice on applying the coating material are typically available from the manufacturer. Specification by product name/manufacturer limits competition and may result in higher material costs. Refer to CFR 48 1-10.002 and ER 1110-2-1200 concerning restrictions on specifying proprietary products.

b. Specification by material description. A material description that provides the compositional, mechanical, and physical characteristics of the thermal spray material may be used. This method should generally be used to specify thermal spray materials for USACE projects. In addition to thermal spray material compositional, mechanical, and physical characteristics, the description also provides a means for material classification, acceptance, certification, testing, manufacture, wire sizes, packaging forms, feedstock identification, and marking of packages.

3-3. Procurement

Thermal spray feedstock materials are typically purchased by the contractor, and, in such cases, it is the contractor's responsibility to procure material that meets the specification requirements. The USACE does not generally provide thermal spray materials to a contractor because the USACE would be responsible for storage, short or excess supply, timely delivery, and waste disposal.

3-4. Classification

Thermal spray materials are classified based on chemical composition and mechanical and physical characteristics. Figure 3-1 shows the nomenclature used to designate the thermal spray wire and ceramic rod

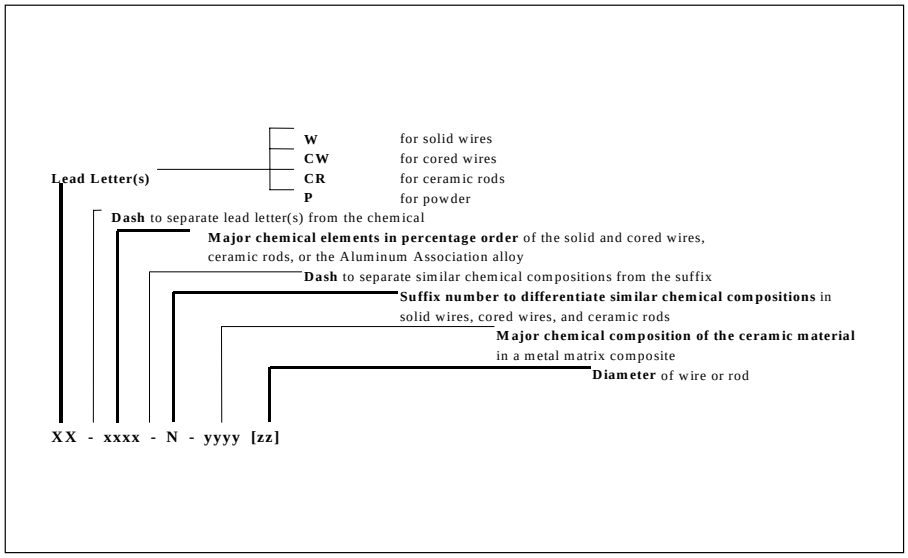

Figure 3-1. Thermal spray feedstock designation nomenclature

feedstock. The description does not address powder feedstock materials. Powder feedstocks are not often used for large-scale production activities. However, if powder feedstock is to be used, it is recommended that the material be held to the same compositional requirements as the equivalent wire material.

3-5. Acceptance

Criteria for acceptance, quality control, and level of testing are described by ANSI/AWS A5.01, "Filler Metal Procurement Guidelines." Acceptance of thermal spray materials is based on the fulfillment of the testing requirements described by ANSI/AWS A5.01. A level of testing as defined in ANSI/AWS A5.01 is ordinarily specified in the procurement document. If the level of testing is not specified, then the manufacturer's standard testing level is assumed. This level of testing is designated as Schedule F in Table 1 of ANSI/AWS A5.01. In general, for USACE projects, Schedule H level of testing from ANSI/AWS A5.01 should be used as the basis for accepting thermal spray feedstock materials. Schedule H level of testing is chemical analysis only, for each lot of material supplied.

3-6. Certification

The manufacturer should certify that the thermal spray material meets the requirements of the material description. Certification implies that the required testing was performed on material representative of that being shipped and that the product conforms to the testing requirements of the specification. Representative material is defined as any material from any production run of the same class of material with the same formula. Certification does not necessarily mean that tests were run on the actual material being supplied.

3-7. Sizes

Thermal spray wire specified for USACE projects will generally be supplied in 3.2-mm (1/8-in.) and 4.8-mm (3/16-in.) diameters. USACE contractors should be allowed to purchase wire sizes appropriate for the equipment to be used on the job.

3-8. Packaging

Thermal spray wire is supplied in coils with and without support, spools, and drums. Standard package weights and dimensions are common. Nonstandard sizes and weights may be supplied as agreed between the supplier and purchaser. The dimension and weight of coils without support are by agreement between the purchaser and supplier. In general, for USACE jobs, the contractor should be allowed to procure wire in standard packages consistent with the requirements of the work to be performed. Appropriate packaging is designed to protect the thermal spray material from damage during shipment and storage.

3-9. Identification and Marking

All thermal spray materials should be properly identified by marking each spool, coil, or drum. Coils without support are marked by an attached tag. Coils with support are marked on the support itself. Spools are marked on the flange of the spool. Drums are marked on the top and side. As a minimum, markings generally contain information about the product, including the material classification, manufacturer's name and product designation, size and weight, heat number, and precautionary information.

3-10. Manufacture

Thermal spray wire may be manufactured by any process, provided that the material meets the requirements of the specification. The manufactured wire should have a smooth finish, free of defects that may affect the feeding of the wire to the thermal spray gun. Such defects include slivers, depressions, scratches, scale, laps, and surface contaminants. A small amount of lubricant may be used on some wire feedstocks to improve wire feeding. Wire may be welded together as supplied to provide for a single continuous wire in a package. Welded wire should be smooth and should not interfere with feeding. The temper of thermal spray wire should allow for continuous and smooth feeding of the wire during spray application. The wire should be wound such that there are no kinks, waves, sharp bends, or overlaps that interfere with wire feed in the thermal spray equipment. The free end of the wire should be secured to prevent unwinding and should be marked for easy identification.

3-11. Testing

Thermal spray testing generally falls into two categories, testing of the feedstock materials and testing of the applied coating. This section addresses the testing of feedstock materials only.

a. Chemical composition. Table 3-1 gives the chemical composition requirements for aluminum, zinc, and alloy thermal spray wires. Chemical composition is determined by various ASTM test methods utilizing emission spectrochemical analysis, inductively coupled plasma spectroscopy, and wet chemistry techniques.

b. Surface appearance. Surface appearance is determined by visual examination of the wire for defects that may interfere with the smooth feeding and application of the wire. Such defects are described above in paragraph 3-10.

c. Cast and helix. This test involves cutting, from a standard package, a specimen that is long enough to form a single loop. The loop of wire, when placed on a flat surface, should form a circle with a diameter of at least 38 cm (15 in.). The loop should not rise more than 2.5 cm (1 in.) above the flat surface. Cast and helix requirements are not applicable to soft alloy wires, including aluminum, copper, and zinc. Most of the feedstock materials used by USACE are soft alloys, and the cast and helix test is not generally a problem.

Table 3-1
Chemical Composition Classification of Aluminum, Zinc, and Alloy Thermal Spray Wires

Classi-fication	Common Name	Composition, Wt % (a)										Other Elements	
		Al	Cr	Cu	Fe	Mn	Pb	Si	Sn	Ti	Zn	Element	Amount
W-Al-1100	1100 Aluminum	99.00 min	...	0.05-0.20	0.95 (Fe+Si)	0.05	...	0.95 (Fe+Si)	...	--	0.1	.(b), (c)..	(b), (c)...
W-Al-1350	1350 Aluminum	99.50 min	0.01	0.05	0.40	0.01	...	0.10	...	0.02 (V+Ti)	0.05	Ga	0.03
W-Al-4043	4043 Silicon Aluminum	rem	--	0.30	0.8	0.05	...	4.5-6.0	...	0.20	0.10	Mg (b)	0.05
W-Al-4047	4047 Silicon Aluminum	rem	...	0.30	0.8	0.15	...	11.0-13.0	...	...	0.20	Mg (b)	0.10
W-Al-5356	5356 Mg Aluminum	rem	0.05-0.20	0.10	0.40	0.05-0.20	...	0.25	...	0.06-0.20	0.10	Mg (b)	4.5-5.5
W-Al-Al_2O_3	Al MMC (d)	88 min	...	...	...	...	...	...	...	...	...	Al_2O_3 (b)	8-12
W-Zn-1	99.99 Zinc	0.002	...	0.005	0.003	...	0.003	...	0.001	...	99.99 min	Cd	0.003
W-Zn-2	99.9 Zinc	0.01	...	0.02	0.02	...	0.03	...	...	...	99.9 min	Cd	0.02
W-ZnAl-1	98/2 Zinc-Aluminum	1.5-2.5	...	...	...	...	...	...	...	...	rem	non Zn/Al	0.1
W-ZnAl-2	85/15 Zinc-Aluminum	14.0-16.0									Rem	Other	0.05

Notes:
(a) Single values shown are maximum percentages unless a minimum is specified.
(b) 0.0008 Be maxi.
(c) Others: 0.05 max each, 0.15 max total.
(d) Vol% Aluminum Assn. 1060 Alloy (99.6% pur Al) with addition of 8-12 vol% Al_2O_3 powder, 8-10 micron diameter.